Tamera-FixFocus

Membrane FixFocus Mirror as Multifunctional Solar Power Station for Diverse Village Applications

Solar Village
Tamera

In cooperation with

SUN ORBIT GmbH,
Mr. Murad Futehally
(Transweigh (International) Pvt Ldt)
& Klaus Langner
(LATRONIC SUNPOWER PTY LTD)

Presentation held by

Jürgen Kleinwächter

on January 22nd, 2018
at Consolfood Conference 2018
in Faro, Portugal

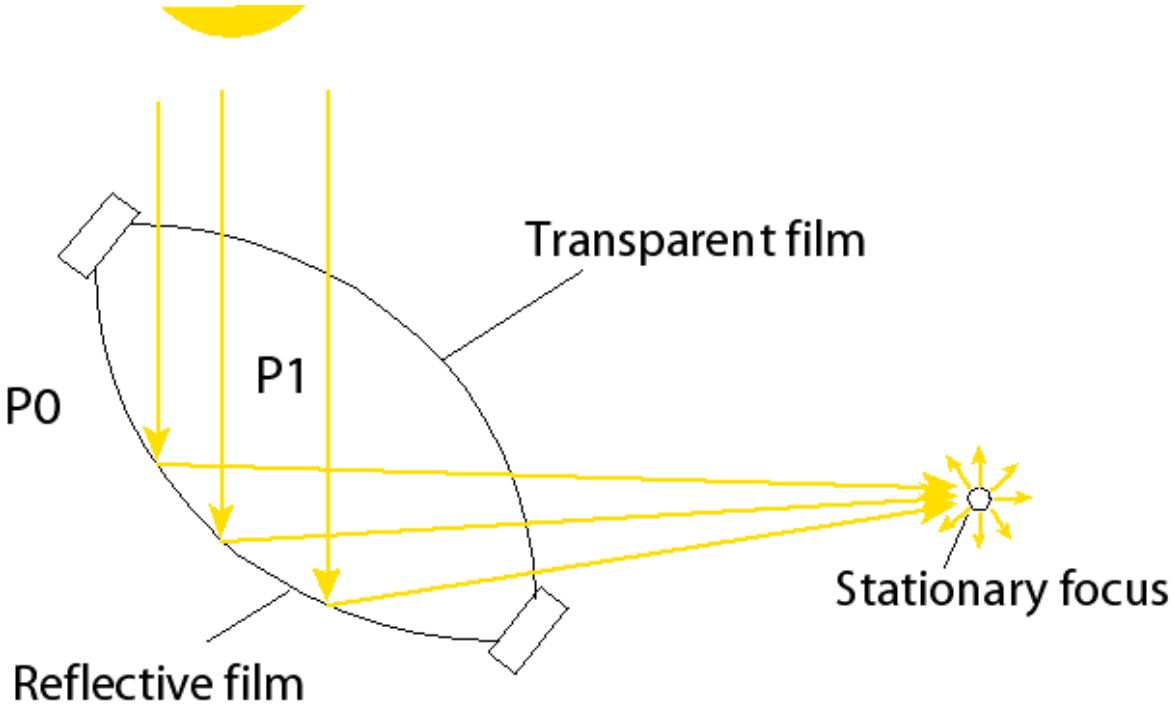
“You can never change things
by fighting the existing reality.
To change something, build a new model
that makes the existing obsolete.”

- R. Buckminster Fuller

Content

1 Main Features

1.) Inflatable, eccentric paraboloid membrane mirror segment

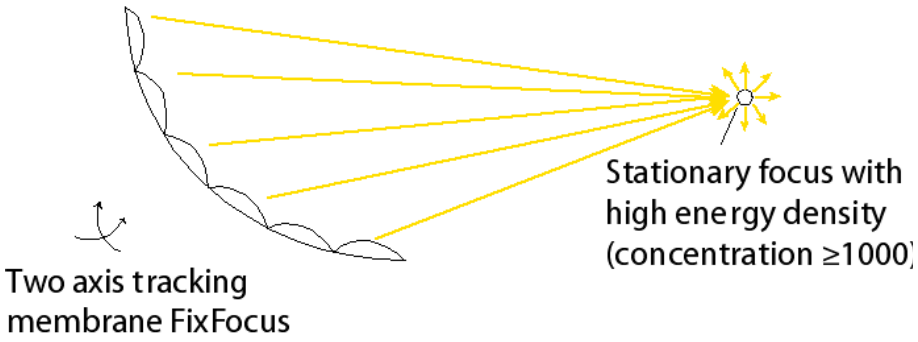


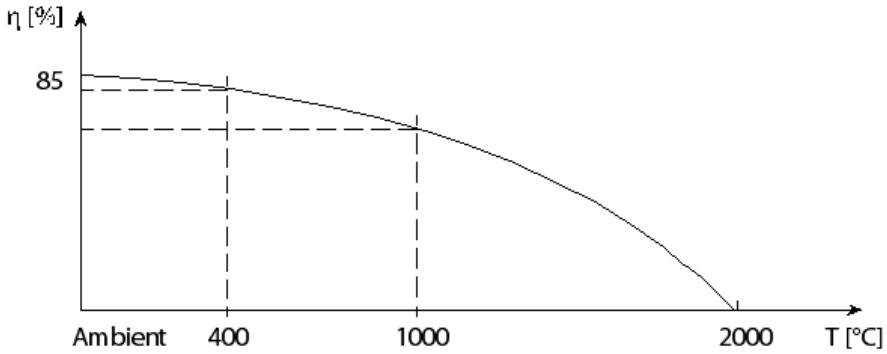
- **Precise form** achieved by inflating the segment with slight overpressure
- Self-cleaning, long-life (>30 years)
  ETFE films are stable even against hail and storms

P1 = air pressure in segment
P0 = ambient air pressure
P1 > P0

1 Main Features

2.) Superposition of the foci of 6 Segments into one stationary Focus



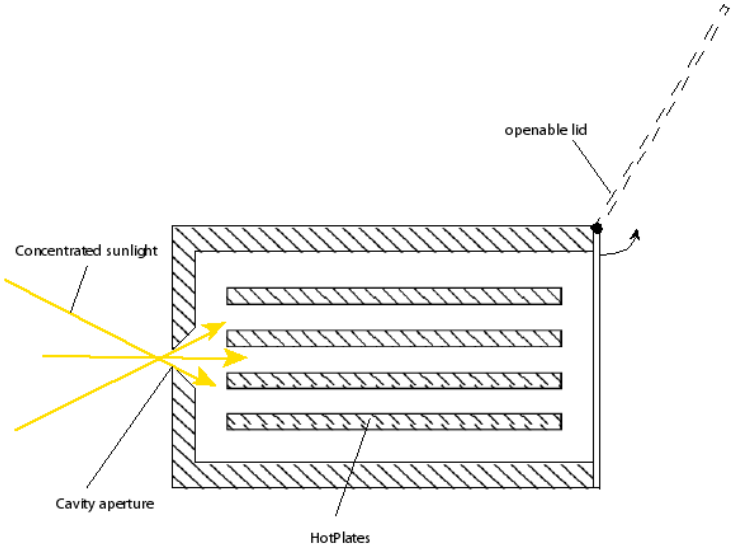


- Mirror automatically tracks the sun in 2-axes. Focus stays fixed all year.
- High efficiencies for cooking in 400°C radiant oven (η ≈ 75%), process heat of 1000°C (η ≈ 60%) and higher temperatures, due to concentration

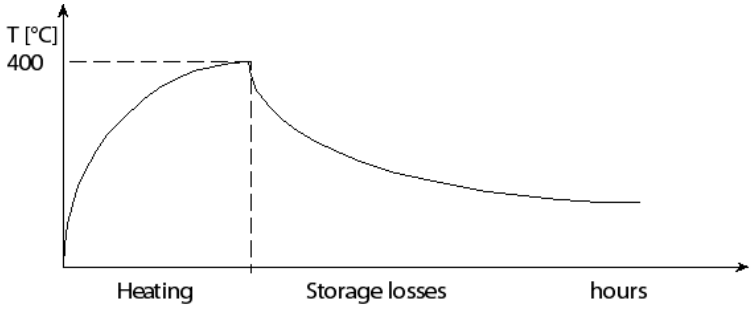
1 Main Features

3.) Combination with cavity receiver

- "HotPlates" in the cavity receiver are heated to the desired operation temperature (eg. 400°C for cooking, frying and baking) with a high efficiency of 75% of the incident solar radiation



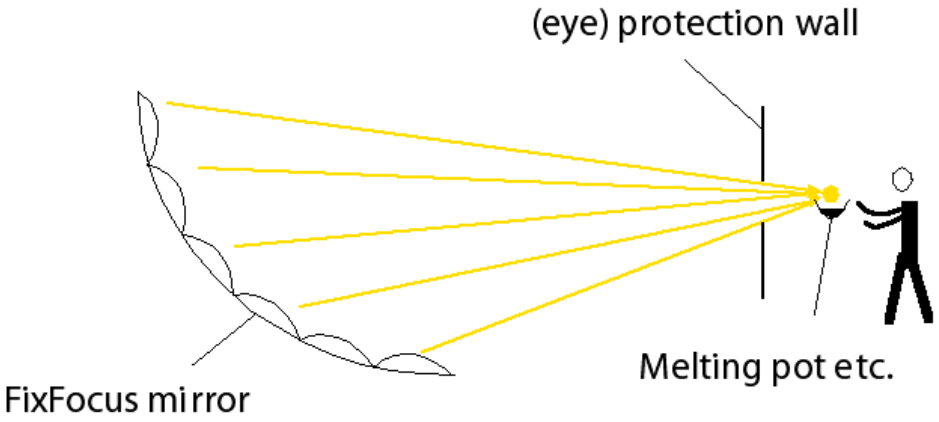
- Due to **well insulated cavity** walls and the fact that the radiation of the HotPlates can only escape through the small cavity aperture, the cavity itself (with its load of HotPlates) **is an excellent thermal storage**. At night time, an extra lid closes the cavity, thus further reducing the losses.



- The **HotPlates can either remain fixed** within the cavity and serve as radiant platforms, typically for cooking, frying, baking around the clock, **or be individually removed** from the cavity **to prepare meals at a distance** from the cavity (typically for surrounding houses).

1 Main Features

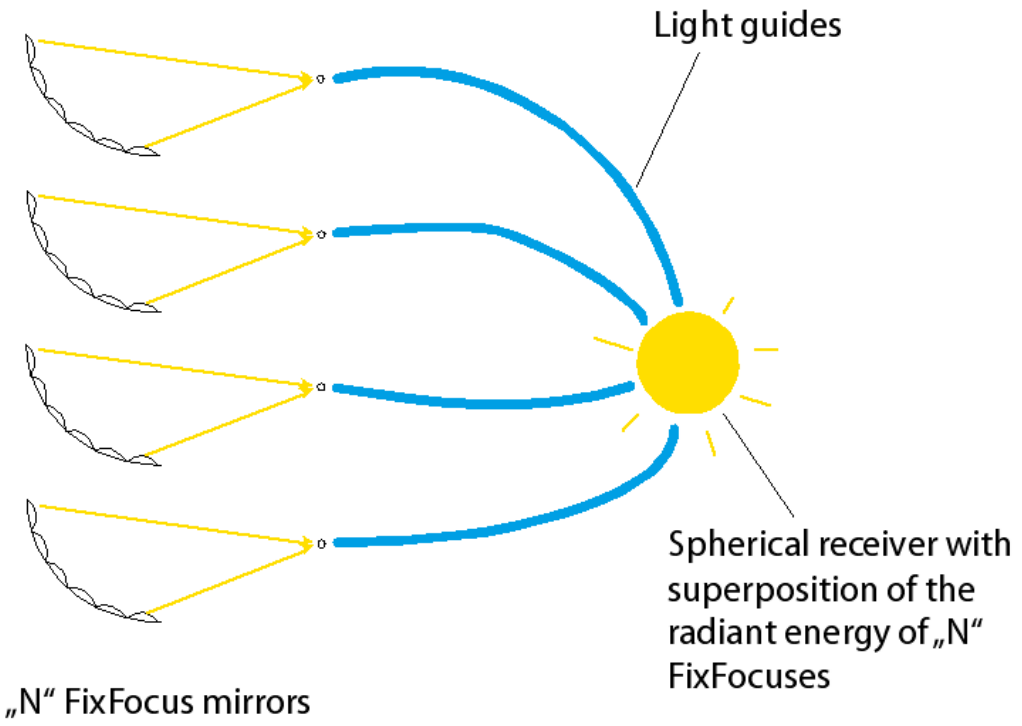
4.) Direct melting of metals, ceramics etc. in the focus



- The fixed focus makes it easy to protect the operator against the concentrated radiation

1 Main Features

5.) Combining the energy of “N”-FixFocuses

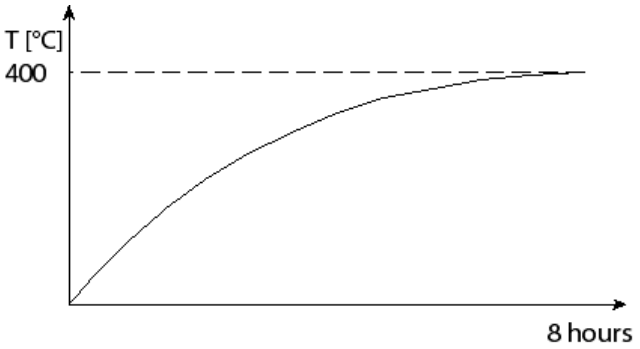


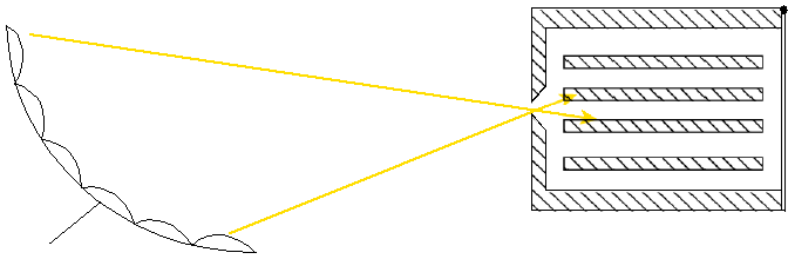
- Adapts the amount of energy to processes like lime burning, running Stirling engines and others.
- We have developed “liquid light guides” well adapted for this tasks
- The superposition of the energy in the spherical receiver should allow for temperatures > 2000°C.

2.1 Cooking, frying and baking … around the clock

(a) Storing the whole day's solar heat within the cavity

- For farmers and other workers who are absent the whole day and want to cook their meal when they return home.





FixFocus mirror

- In this case, enough cooking plates are positioned within the cavity to be heated to a desired temperature (typically 400°C) during the day

2.1 Cooking, frying and baking … around the clock

How many kilos of granite stones can be heated from ambient temperature to 400°C during a sunny day of 8 hours?

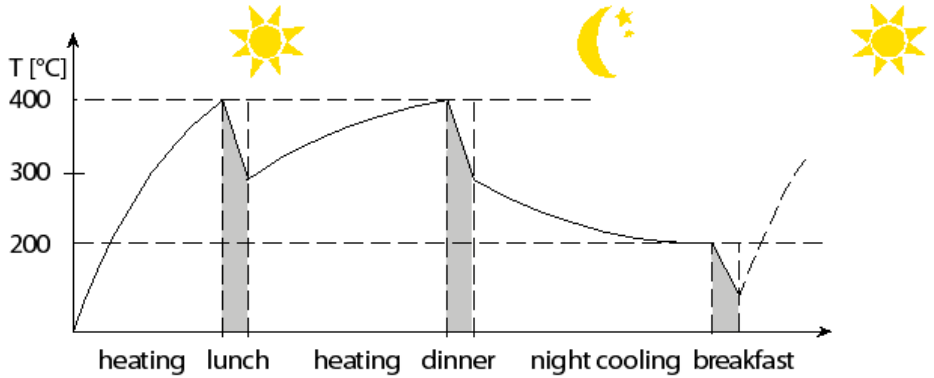
Basic parameters for an optimized system:

Mirror Aperture Size	3,5 m^2
Optical Efficiency	75 %
Intercept factor	0,9
Receiver Efficiency	70 %
Direct radiation during 8 hrs.	800 W/m^2
Reflected power into the cavity	1,3 kW
Reflected energy in cavity during 8 hrs.	11 kWh
Heat capacity of granite stone	790 J/kg·K
Absorbed heat by heating the stones to 400K	300 kJ/kg
Conversion	1 kJ = 0,00028 kWh
Mass of stones heated to 400 °C within 8 hrs.	126 kg

2.1 Cooking, frying and baking … around the clock

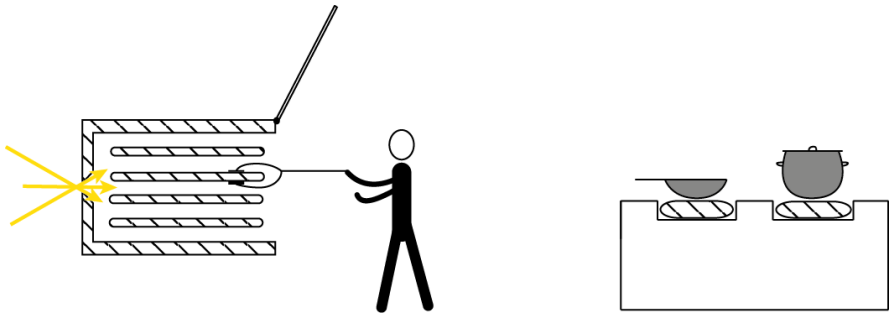
(b) Cooking around the clock in the radiant cavity

If hot meals are required at noon, the evening and the next morning, less cooking stones are positioned into the cavity, so that at noon they have already reached 400°C. After cooking lunch, the stones are again exposed to the sun, so that in the evening, dinner can be cooked and enough heat remains stored so that breakfast (chapatis, tea, coffee, etc.) can be prepared the next morning.



2.1 Cooking, frying and baking … around the clock

(c) Using the "Hot Stones" as individual, transportable cooking platforms



Individual stones are picked up by a gripper and transported to a house with a table on which the stones are placed and used to prepare individual meals. After cooking, the plates are reintroduced into the FixFocus cavity. Somewhat similar to Japanese hot stone cooking but using the sun!

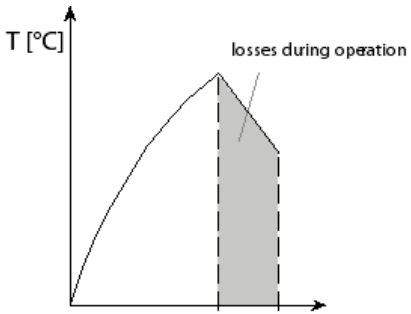
2.1 Cooking, frying and baking … around the clock

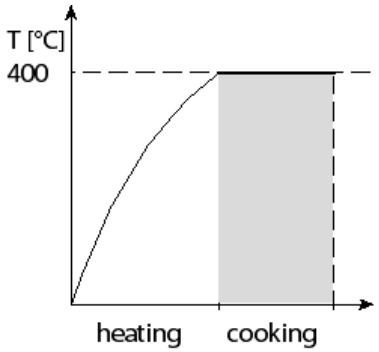
<u>Important notice concerning the Stones:</u>
Stones carry sensible heat – they loose temperature during operation.

Therefore I propose to use hollow steel boxes containing a eutectic salt which changes phase (solid to liquid) at ≈ 400°C. By cooking on these stones, the temperature stays constant until the salt re-solidifies.

A good candidate is the eutectic $MgCl_2$+NaCl+KCl. Its melting point is 385°C. It can absorb 461 kJ/kg instead of 300 kJ/kg of the stones and stays isothermal during the whole cooking process!

Furthermore, by heating the cavity to over 400°C, during night-time the walls of the cavity help to keep the eutectic liquid, so that the full temperature (385°C) can in principal also be obtained the next morning!

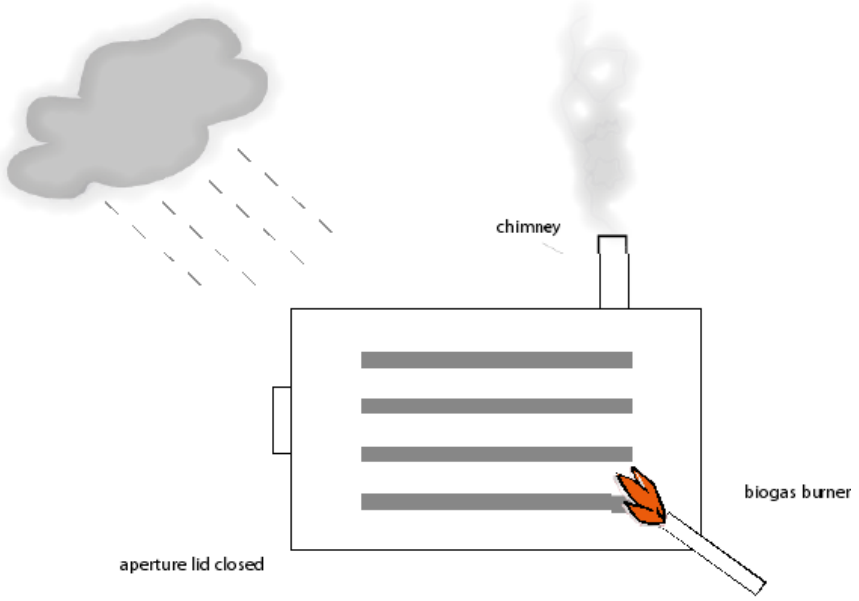




2.1 Cooking, frying and baking … around the clock

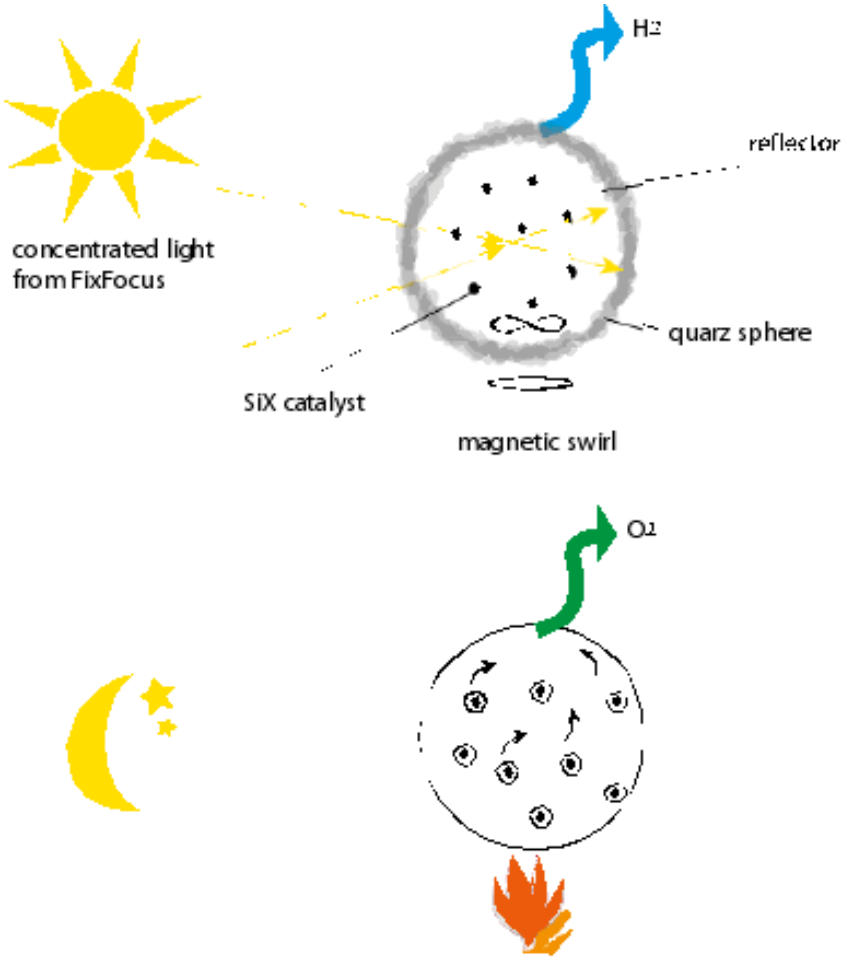
(d) Combining with biogas burner or wood burner

For sunny countries (like India) the bulk of the cooking during the year will be executed by the sun. For longer bad weather periods, a biogas or wood burner can be integrated in the cavity.



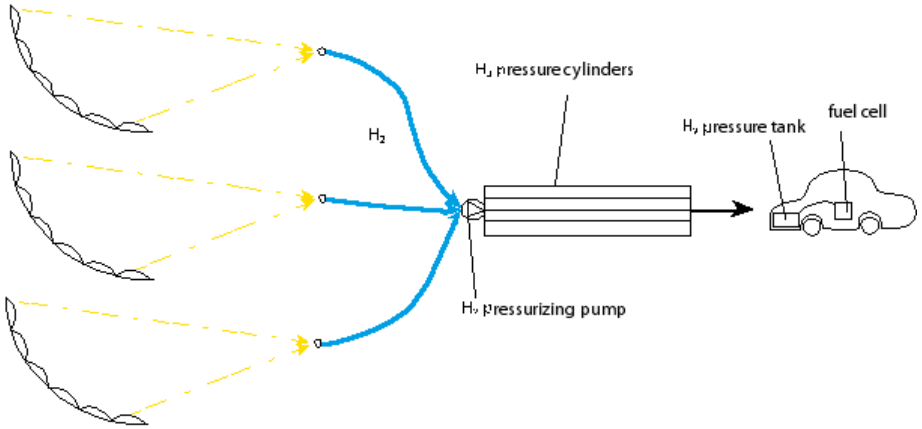
2.2 Solar Water Splitting

The “Holy Grail”: direct photonic splitting of water



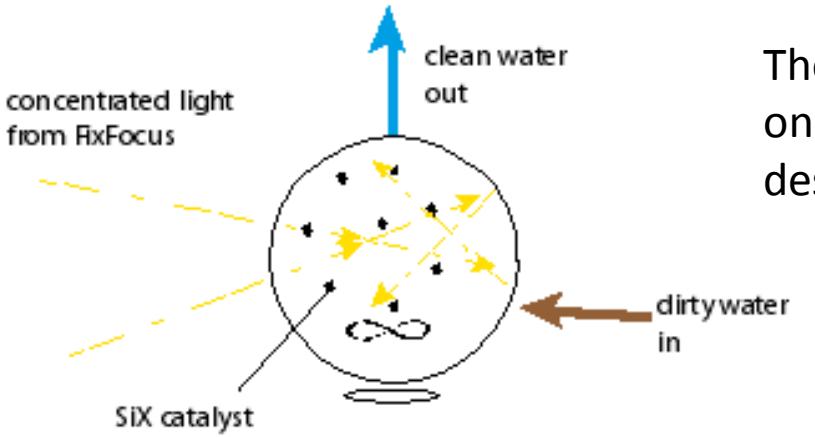
- Within a quartz sphere filled with water, SiX Catalyst powder is moved by a magnetic stirrer.
- Concentrated light from the FixFocus illuminates the SiX photocatalyst. H2 is produced directly.
- During night time the O2 molecules which wrapped around the SiX catalyst are set free by briefly heating the water-SiX mixture to 100°C; after this initial phase of endothermal heat input the oxygen gas is expulsed in a strong exothermal process.

2.3 The Solar “Gasoline” Station



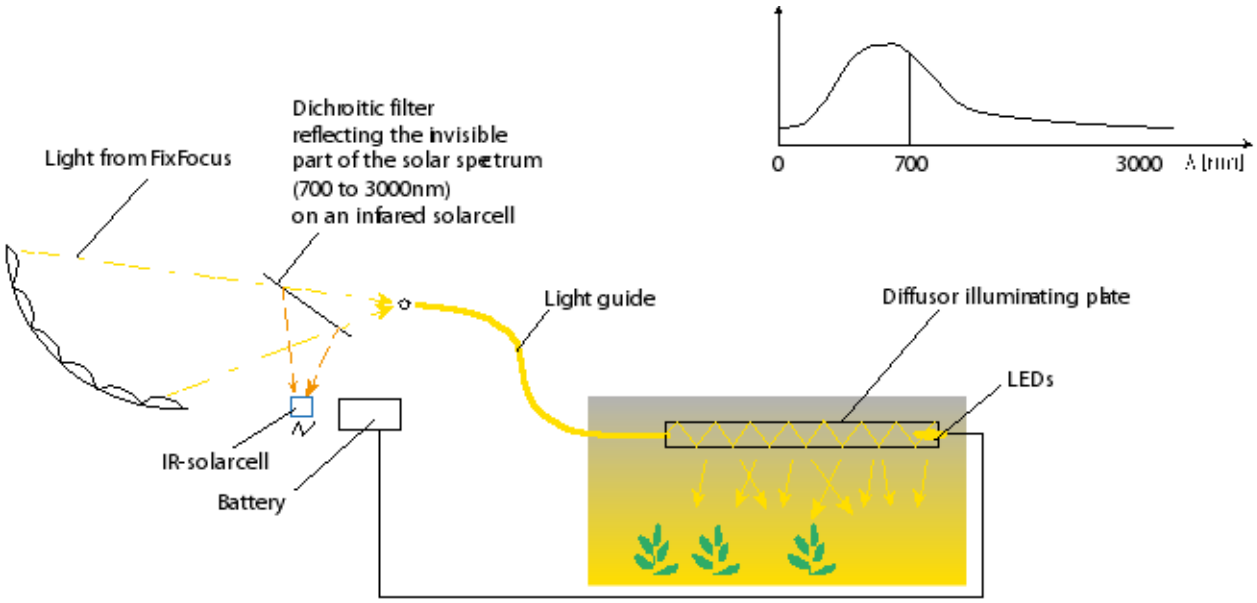
- N FixFocus mirrors produce hydrogen during daytime. This is pumped under pressure into storage cylinders.
- A fuel cell equipped car fills its H2 pressure tank within few minutes
- The fuel cell creates electricity by recombining H2 and O2. The wheels of the car are driven electrically. Beside this power, only pure H2O leaves the exhaust.

2.4 Photocatalytic Water Cleaning



The concentrated light produces free OH radicals on the surface of the catalyst, effectively destroying the pollutants in the water.

2.5 Illumination of rooms, caves, Underearth Grennhouses etc.



- During daytime a large room (or greenhouse etc.) is illuminated with natural light (400 – 700nm) by a large diffuser plate, diffusing the intense, concentrated radiation.

- At night time, LEDs in the same diffuser plate continue illuminating the room. The energy to operate the LEDs was harvested during the day from the (invisible) infrared part of the spectrum.

3 Other Interesting Applications

Concentrated sunlight represents a clean and abundant source of energy with high exergy content (possibility to transform the light to mechanical work, high temperatures etc.) Practically all technologies which are based today on the utilization of high temperature industrial ovens can be realized without pollution or dangerous emissions, decentrally and already on the village scale.
In brief, some further applications:

- running Stirling and other engines such as steam engines
- driving thermochemical, reversible heat storage
- producing hot process-air
- stimulating the fantasy of FixFocus users to continue finding new exciting applications.

Let’s get this process started!

Thank you for your attention!